

CARBON DIOXIDE (CO<sub>2</sub>) LASER CUT QUALITY OF  
ACRYLIC

AHMAD SHAZWI BIN KAMARUZAMAN

UNIVERSITI MALAYSIA PAHANG

CARBON DIOXIDE (CO<sub>2</sub>) LASER CUT QUALITY OF ACRYLIC

AHMAD SHAZWI BIN KAMARUZAMAN

Report submitted in partial fulfillment of the requirements  
for the award of the degree of  
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering  
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2008

### **SUPERVISOR'S DECLARATION**

“We hereby declare that we have checked this thesis and in our opinion this project is sufficient in terms of scope and quality for the purpose of the degree of Bachelor of Mechanical Engineering.”

Signature : .....  
Name of Supervisor : Nurul Shahida Binti Mohd Shalahim  
Position : Supervisor  
Date : .....

Signature : .....  
Name of Panel : Zamri Bin Mohamed  
Position : Panel  
Date : .....

### **STUDENT'S DECLARATION**

I hereby declare that this thesis entitled “Carbon dioxide (CO<sub>2</sub>) laser cut quality of Acrylic” is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : .....

Name : AHMAD SHAZWI BIN KAMARUZAMAN

ID Number : MA05055

Date : .....

## TABLE OF CONTENTS

	<b>Page</b>
<b>SUPERVISOR’S DECLARATION</b>	ii
<b>STUDENT’S DECLARATION</b>	iii
<b>ACKNOWLEDGEMENTS</b>	iv
<b>ABSTRACT</b>	v
<b>ABSTRAK</b>	vi
<b>TABLE OF CONTENTS</b>	vii
<b>LIST OF TABLES</b>	x
<b>LIST OF FIGURES</b>	xi
<b>LIST OF SYMBOLS</b>	xiii
<b>LIST OF ABBREVIATIONS</b>	xiv
 <b>CHAPTER 1      INTRODUCTION</b>	
 1.0      Introduction	1
1.1      Problem Statement	2
1.2      Objectives	3
1.3      Project Scopes	3
1.4      Thesis organization	4
 <b>CHAPTER 2      LITERATURE REVIEW</b>	
 2.0      Introduction	5
2.1      Laser	7
2.1.1    The maser	8
2.1.2    The laser	8
2.1.3    Laser chronology	10

2.2	Basic component and working principle	11
2.3	Laser Cutting	13
2.4	CO <sub>2</sub> laser	14
2.5	Acrylic	16
2.5.1	Advantages and disadvantages of Acrylic	17
2.5.2	Application of Acrylic	17
2.6	Cut quality	18
2.6.1	Kerf width	18
2.6.2	Surface roughness	19

### **CHAPTER 3      METHODOLOGY**

3.0	Introduction	20
3.1	Literature study	20
3.2	Experimental procedure	21
3.3	Experimental parameter	24
3.4	Drawing of sample	25
3.5	Cutting of material	26
3.6	Analyzing of cut quality	27
3.6.1	Surface roughness	28
3.6.2	Kerf width	29
3.7	Result analysis	30

### **CHAPTER 4      RESULTS AND DISCUSSION**

4.1	Introduction	31
4.2	Machinery experimental result	32
4.3	Results of surface roughness	38
4.4	Effects of power on surface roughness	40
4.5	Results of kerf width	43

4.6	Effects of power on kerf width	45
4.7	Comparison between theoretical	47
4.8	Error discussion	48

## **CHAPTER 5      CONCLUSION AND RECOMMENDATIONS**

5.1	Conclusions	49
5.2	Recommendations	50

<b>REFERENCES</b>	<b>52</b>
-------------------	-----------

<b>APPENDICES</b>	<b>53</b>
-------------------	-----------

**LIST OF TABLES**

<b>Table No.</b>		<b>Page</b>
2.1.3	Laser chronology	11
2.5	Properties of Acrylic	17
3.3	Data of the experiment	25
3.7	Result data	31
4.2	Parameter of cutting process	33
4.3	Result of surface roughness, $R_a$	40
4.5	Result of kerf width	45



## LIST OF FIGURES

Figure No.		Page
2.0	Flowchart of Chapter 2	6
2.2.1	Electromagnetic waves	11
2.2.2	Basic components of laser	11
2.2.3	Pumping energy	12
2.6.1	Kerf width region	18
2.6.2	Surface roughness structure	19
3.2.1	General flow chat	22
3.2.2	Experiment flow chat	23
3.4	(2-D view) of specimen	25
3.5	Laser Cutting Machine	26
3.6.1.1	Three different points to measure surface roughness	28
3.6.1.2	Perthometer	28
3.6.2.1	Slit region to measure kerf width	29
3.6.2.2	Image Analyzer	29
4.1	Specimen	33
4.1.1	Parameter Setup	34

4.1.2	Move sample to origin	35
4.1.3	Tool Database	35
4.1.4	Sequencing and Material setup	36
4.3	Surface roughness structure after cut using laser cutting machine	38
4.4	Graph Surface Roughness vs. Power	40
4.4.1	Surface roughness at 15 W	42
4.4.2	Surface roughness at 28.5 W	42
4.5	Kerf width structure after cutting using laser cutting machine	43
4.6	Graph kerf width vs. Power	45

**LIST OF SYMBOLS**

W	Watt
Mm	Millimeter
SR	Surface Roughness
R <sub>a</sub>	Coefficient for surface roughness
F	Fahrenheit
C	Celsius
R	Hardness
Hz	Hertz
μm	Micrometer
Cm	Centimeter
μm	Micrometer

**LIST OF ABBREVIATIONS**

EDM	Electro Discharge Machining
UV	Ultraviolet
IR	Infrared
CNC	Computer numerical control
PC	Personal computer
AISI	American Iron and Steel Institute
GPA	Giga Pascal
ANOVA	Analysis of variance
PSI	Pounds per square inch
CAD	Computer-aided design